MULTISTAGE CENTRIFUGAL COMPRESSOR HAVING A TANK WHICH CAN BE OPENED HORIZONTALLY

The present invention relates to a multistage centrifugal compressor having a tank which can be opened horizontally.

The fundamental elements forming a multistage centrifugal compressor are a shaft equipped with a series of rotors or wheels, rotating round the machine axis, and a series of diffusors or diaphragms with return channels between the various stages, integral with a tank which contains said compressor.

Each rotor consists of a series of bladed disks assembled on the same shaft.

A diffusor follows each rotor disk.

Each diffusor is associated with a return channel, which conveys the fluid to the subsequent rotor.

The whole set of each rotor together with the relative diffusors and return channels forms a stage, which is separated from the adjacent ones by annular diaphragms

and labyrinth-seal systems to avoid recycling between one stage and the other.

The centrifugal compressors are equipped with diaphragms consisting of two semi-diaphragms.

During the functioning of the multistage centrifugal compressor, the diaphragms are subjected to an axial force caused by the pressure differences due to compression of the fluid.

In order to counterbalance this force, it is therefore necessary to fix said semi-diaphragms to the stator of the multistage centrifugal compressor.

A bearing ring is envisaged for each single diaphragm, which is divided into an upper half-ring and a lower half-ring.

Each lower half-ring is welded to the lower tank, and the corresponding upper half-ring is welded to the upper tank.

Each upper semi-diaphragm is fixed to the corresponding upper half-ring, whereas each lower semi-diaphragm is fixed to the corresponding lower half-ring.

This is because the semi-diaphragms undergo axial stress during the functioning of the compressor and, without the supporting rings, they would tend to move, causing, among other things, sealing problems among the various stages.

The assembly of the semi-diaphragms in the tanks is extremely difficult, as it is necessary to centre all the semi-diaphragms with the respective half-rings and also to centre the lower semi-diaphragms with the corresponding upper semi-diaphragms.

At the same time, it is extremely important to keep the seal between the various stages of the centrifugal compressor.

For this reason, the semi-diaphragms are always fixed in advance to the corresponding half-rings.

In the assembly of a multistage centrifugal compressor, all the lower semi-diaphragms are first inserted into the lower tank, followed by the shaft with the rotors.

Similarly, the upper semi-diaphragms are inserted and fixed to the upper tank.

The upper tank can be assembled on the lower tank after being lifted by means of a bridge-crane, overturned and correctly placed on the lower semi-tank, in order to centre all the semi-diaphragms.

High capacity/pressure multistage centrifugal compressors can be extremely heavy, up to 350 tons, and consequently the upper tank, with the upper semi-diaphragms fixed, can weigh even 150-200 tons.

One of the disadvantages is that costly lifting sys-

tems are necessary, capable of lifting the total weight of the upper tank on which the upper half-rings have been welded and the upper semi-diaphragms respectively fixed to the upper half-rings.

Another disadvantage is that it is not possible to effect controls on the positioning of the components inside the tank.

Furthermore, for maintenance, which is quite a common operation, such as the substitution of the labyrinth seal system, the overturning of the upper tank is required.

A further disadvantage is that in the case of particularly large and heavy machines, the overturning of the upper tank requires costly and complex equipment.

The objective of the present invention is to provide a multistage centrifugal compressor having a tank which can be opened horizontally, which is simple and with reduced costs and production times.

A further objective is to provide a multistage centrifugal compressor having a tank which can be opened horizontally, having reduced costs and assembly times.

Another objective is to provide a multistage centrifugal compressor having a tank which can be opened horizontally, which allows a higher safety level during maintenance operations.

Yet another objective is to provide a multistage centrifugal compressor having a tank that can be opened horizontally, which allows the dimension of the bridge-crane, necessary for assembling the multistage centrifugal compressor, to be reduced.

A further objective is to provide a multistage centrifugal compressor having a tank that can be opened horizontally, which allows reduced maintenance costs and times.

These objectives, according to the present invention, can be achieved by producing a multistage centrifugal compressor having a tank which can be opened horizontally, comprising a lower semi-tank 11, an upper semi-tank 12, a shaft 13 equipped with a series of rotors 14 and a series of stages 10, each of which, in turn, includes a series of lower semi-diaphragms 16 and a series of upper semi-diaphragms 18, a lower half-ring 21 and an upper half-ring 22, which can be coupled to form a supporting ring, said lower half-ring 21 being fixed inside the lower semi-tank 11 and the corresponding upper half-ring 22 being fixed inside the upper semi-tank 12, characterized in that in each stage 10 of the multistage centrifugal compressor, the lower semi-diaphragms 16 are rigidly constrained to one another by blocking means, to form a first pile 41 of lower semi-diaphragms 16 and the

corresponding upper semi-diaphragms 18 are rigidly constrained to one another by blocking means, to form a second pile 42 of lower semi-diaphragms 16, and in that said first pile 41 can be constrained to said lower half-ring 21 and said second pile 42 can be constrained to said upper half-ring 22.

Further characteristics of the invention are illustrated in the following claims.

The characteristics and advantages of a multistage centrifugal compressor having a tank which can be opened horizontally according to the present invention, will appear more evident from the following illustrative and non-limiting description, referring to the enclosed schematic drawings, in which:

figure 1 is a raised, partially sectional view of the right side, according to a preferred embodiment of the present invention;

figures 2a, 2b, 2c and 2d are exemplified perspective schematic views of a preferred assembly of a centrifugal compressor stage, according to the present invention.

With reference to the figures, these show a stage of a multistage centrifugal compressor having a tank which can be opened horizontally, comprising a lower semi-tank 11 and an upper semi-tank 12, a shaft 13 having a series

of rotors 14 and a series of stages 10 each of which comprising, in turn, a series of lower semi-diaphragms 16 and a series of upper semi-diaphragms 18.

The multistage centrifugal compressor also includes, for each stage 10, a lower half-ring 21 and an upper half-ring 22, which can be coupled to form a supporting ring.

Said lower half-ring 21 is fixed inside the lower semi-tank 11 and said corresponding upper half-ring 22 is fixed inside the upper semi-tank 12.

In each stage of the centrifugal multistage compressor, only one lower half-ring 21 and one upper half-ring 22 are present in order to hold the corresponding lower semi-diaphragms 16 and the corresponding upper semi-diaphragms 18, respectively.

Said lower half-ring 21 constrains a lower semi-diaphragm 16 to the lower tank 11, so that said lower semi-diaphragm can bear the axial stress during the functioning of the centrifugal multistage compressor.

Analogously, said upper half-ring 22 constrains an upper semi-diaphragm 18 to the upper tank 12 for the same reason described above.

Each lower semi-diaphragm of the series of lower semi-diaphragms 16, is coupled with and can be constrained, by means of fixing means, to the respective up-

per semi-diaphragm of the series of the upper semi-diaphgrams 18, to form a whole diaphragm 30, having a central pass-through hole in which the shaft 13 is inserted.

The fixing means preferably include screws 15 or tie-rods which can be inserted in suitable housings situated in the lower semi-diaphragms 16 and upper semi-diaphragms 18.

Furthermore, the lower semi-diaphragms 16 of each stage are packed and tightly constrained to one another by blocking means, and, at the same time, the upper semi-diaphragms 18 of each stage are also packed and tightly restrained to one another by blocking means.

The blocking means include screws, tie-rods and pins.

A first pile 41 of lower semi-diaphragms 16 and a second pile 42 of upper semi-diaphragms 18 are thus obtained for each stage 10 of the multistage centrifugal compressor.

It is also evident that, as a whole, the multistage centrifugal compressor has a set of first piles 41 of lower semi-diaphragms 16 and a set of second piles 42 of upper semi-diaphragms 18.

The correct positioning and centering during the assembly of the multistage centrifugal compressor is there-

fore highly facilitated, as each first pile 41 and each second pile 42 can be easily moved and positioned, due to the fact that the semi-diaphragms are tightly constrained to one another and consequently there is no possibility of relative movement among them.

In particular, each second pile 42 can be positioned on the corresponding first pile 41, regardless of the upper semi-tank of the compressor.

Each first pile 41 of lower semi-diaphragms 16, is constrained to the corresponding lower half-ring 21 and, in the same way, each second pile 42 of upper semi-diaphragms 18, is constrained to the corresponding upper half-ring 22.

This is to balance the axial forces acting on the series of diaphragms during the functioning of the multistage centrifugal compressor and to centre them with respect to the tank.

The diaphragms can therefore transmit, through the blocking means, the stress received during the functioning of the multistage centrifugal compressor, to the supporting ring, and subsequently to the lower semi-tank 11 and upper semi-tank 12 of the multistage centrifugal compressor, at the same time maintaining the seal between the various stages.

Furthermore, for the assembly of the multistage cen-

trifugal compressor, it is possible to assemble the empty upper semi-tank, with a considerable advantage both for the equipment, lifting and moving cost as well as from a safety point of view for the whole operation.

According to another aspect of the present invention, a procedure is provided, for the assembly of a multistage centrifugal compressor, comprising the stages of (a) forming a series of first piles of lower semi-diaphragms 16, and a series of second piles 42 of upper semi-diaphragms 18, (b) assembling a first pile 41 of lower semi-diaphragms 16, in the lower semi-tank 11, in each stage, by constraining a lower semi-diaphragms 16 of each first pile 41 to the lower half-ring 21, (c) assembling the shaft 13 equipped with the series of rotors 14 on the series of first piles 41 of lower semi-diaphragms 16, (d) coupling and constraining the series of second piles 42 with the series of first piles 41, (e) assembling the upper semi-tank 12 on the lower semi-tank 11, constraining an upper semi-diaphragm 18 of each second pile 42 to the corresponding upper half-ring 22 and (f) closing the multistage centrifugal compressor.

In stage (a) each first pile 41 of lower semi-diaphragms 16 and each second pile 42 of upper semi-diaphragms 18, is obtained by constraining the lower semi-diaphragms 16 of each stage to each other and, in

the same way, by constraining the upper semi-diaphragms 18 to each other.

Stage (a) is preferably effected by constraining the lower semi-diaphragms 16 to each other, by means of axial screws 17, and by constraining the upper semi-diaphragms 18 to each other, by means of axial screws 19.

Stage (d) is preferably effected by constraining each first pile 41 to the corresponding second pile 42 by means of screws 15.

With reference to figures 2a-2d, a preferred way of forming a first pile 41 of lower semi-diaphragms 16 of each stage and a second pile 42 of upper semi-diaphragms 18 of each stage, is to position a lower semi-diaphragm 16 on a flat surface, coupling it and constraining it to a corresponding upper semi-diaphragm 18, to form a complete diaphragm 30.

A further lower semi-diaphragm 16 is subsequently positioned on the first lower semi-diaphragm 16 of the newly formed diaphragm 30, and is respectively coupled and constrained to a further upper semi-diaphragm 18, arranging it above the first upper semi-diaphragm 18.

These operations are repeated several times in order to couple all the semi-diaphragms of a stage of the multistage centrifugal compressor, thus forming all the complete diaphragms, piled up one above the other.

All the lower semi-diaphragms 16 of one stage are then axially constrained by means of axial screws 17 and, in the same way, all the upper semi-diaphragms 18 of the same stage are then axially constrained by means of axial screws 19.

The constraints which join the upper semi-diaphragms 18 of one stage to the corresponding lower semi-diaphragms 16 of the same stage are removed, thus obtaining a first pile 41 of lower semi-diaphragms 16, stacked one on top of another, and a second pile 42 of upper semi-diaphragms 18 stacked one on top of another.

It can therefore be seen that a multistage centrifugal compressor having a tank which can be opened horizontally according to the present invention, achieves the objectives listed above.

The multistage centrifugal compressor having a tank which can be opened horizontally of the present invention, thus conceived, can be subjected to numerous modifications and variations, all forming part of the same inventive concept.

Furthermore, in practice, the materials used, as also their dimensions and components, can vary according to technical demands.